

January 20, 1859.

SIR BENJAMIN C. BRODIE, Bart., President, in the Chair.

The following communications were read :—

- I. "Second Note on Ozone." By THOMAS ANDREWS, M.D., F.R.S., and P. G. TAIT, M.A., F.C.P.S. Communicated by Dr. ANDREWS. Received December 16, 1858.

Since the publication of their "Note on the Density of Ozone" (Proceedings of the Royal Society, June 1857), the authors have been occupied with an extended investigation into the nature and properties of that body. The inquiry having proved more protracted than they anticipated, they have thought it proper to send to the Royal Society a brief notice of some of the more important facts which they have already observed, reserving a description of the methods employed, and of the details of the experiments, for a future communication.

The commonly received statement, that the whole of a given volume of dry oxygen gas contained alone in an hermetically sealed tube can be converted into ozone by the passage of electrical sparks, is erroneous. In repeated trials, with tubes of every form and size, the authors found that not more than $\frac{1}{100}$ part of the oxygen could thus be changed into ozone. A greater effect was, it is true, produced by the silent discharge between fine platina points; but this also had its limit. In order to carry on the process, it is necessary to introduce into the apparatus some substance, such as a solution of iodide of potassium, which has the property of taking up, in the form of oxygen, the ozone as it is produced. After many trials, an apparatus was contrived in the form of a double U, having a solution of iodide of potassium in one end, and a column of fragments of fused chloride of calcium interposed between this solution and the part of the tube where the electrical discharge was passed. The chloride of calcium allowed the ozone to pass, but arrested the vapour of water; so that, while the discharge always took place in dry oxygen, the ozone was gradually absorbed. The experiment is not yet finished, but already one-fourth of the gas in a tube of the

capacity of 10 cubic centimetres has disappeared. To produce this effect, the discharge from a machine in excellent order has been passed through the tube for twenty-four hours.

When oxygen is thus converted into ozone, a diminution of volume takes place. The greatest contraction occurs with the silent discharge, and amounts to about $\frac{1}{3.5}$ of the volume of the gas. The passage of sparks has less effect than the silent discharge, and will even destroy a part of the contraction obtained by means of the latter. If the apparatus be exposed for a short time to the temperature of 250°C. , so as to destroy the ozone, it will be found that the gas on cooling has recovered exactly its original volume. This observation proves, unequivocally, that if ozone be oxygen in an allotropic condition, its density is greater than that of oxygen. Experiments still in progress indicate that the density of ozone obtained by the electrical discharge must, on the above assumption, be represented by even a higher number than that deduced by the authors from their experiments on ozone prepared by electrolysis.

When mercury is brought into contact with dry oxygen, in which ozone has been formed by the electrical discharge, it loses to a great extent its mobility, and may be made to cover the interior of the tube with a fine reflecting surface resembling that of an ordinary mirror. It is remarkable that this great change in the state of the mercury is not accompanied by any further diminution of the volume of the gas. The apparatus employed by the authors would have enabled them to estimate with certainty a change of volume amounting to $\frac{1}{12000}$ part of the whole. On the contrary, on allowing the apparatus to stand, the gas begins slowly to expand; and in thirty hours, when the ozone reactions have disappeared, the expansion amounts to a little more than one half of the contraction which had previously taken place.

Dry silver, in the state both of leaf and of filings, has the property of entirely destroying ozone, whether prepared by electrolysis or by the electrical machine. If a stream of electrolytic ozone be passed over silver leaf or filings contained in a tube, the metal becomes altered in appearance where the gas comes first into contact with it; but no appreciable increase of weight takes place, however long the experiment may be continued. The volumetric results are similar to those already described in the case of mercury.

Arsenic also destroys dry ozone, but, as it likewise combines with dry oxygen, its separate action on ozone cannot be observed with precision.

Most of the other metals examined, such as gold, platina, iron, zinc, tin, &c., are without action on dry ozone.

Iodine, brought into contact with oxygen contracted by the electric discharge, instantly destroys the ozone reactions, and a yellowish solid is formed: no change of volume accompanies this action.

Peroxide of manganese and oxide of copper have, it is well known, the property of destroying ozone, apparently without limit. The authors have found that these oxides undergo no sensible increase of weight, even after the destruction of 50 or 60 milligrammes of ozone. The same oxides, when brought into contact with oxygen contracted by the spark, restore it to nearly its original volume.

Hydrogen gas, purified with care, and perfectly dry, was not changed in volume by the action either of the electrical spark, or of the silent discharge.

A similar negative result was obtained with nitrogen and the silent discharge; but with the spark a very slight alteration of volume appeared to occur, the cause of which is still under investigation.

In the experiments now described, the electrical sparks and discharge were always obtained from the common friction-machine. The discharge from the induction coil, even when passed through two Leyden jars, produces very insignificant ozone effects. The heat which always accompanies this discharge, and its comparatively feeble tension, sufficiently explain its want of energy.

All the results recently obtained by the authors fully confirm the former experiments of one of them,* that in no case is water produced by the destruction of ozone, whether prepared by electrolysis or by the electrical discharge. They reserve any further expression of their views as to the true relations which exist between ozone and oxygen, till they shall have an opportunity of laying the results of this inquiry in a more complete form before the Society.

* Philosophical Transactions for 1856, Part I.